

1 up
E7.3 10355
CR 130970

ARGUS EXPLORATION COMPANY

A Research Subsidiary of
Cyprus Mines Corporation
4120 Birch Street, Suite 108
Newport Beach, California 92660
Telephone (714) 833-3081

"Made available under NASA sponsorship
in the interest of early and wide dis-
semination of Earth Resources Survey
Program information and without liability
for any use made thereof."

15 March 1973

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Attn: NASA Scientific & Technical Information Facility
ERTS Contracting Officer, Code 245 GSFC
ERTS Technical Officer, Code 430, GSFC
ERTS Project Scientist, Code 650, GSFC
ERTS Scientific Monitor, Code 650, GSFC

Subject: Type I Progress Report, 1 January through 28 February 1973
Proposal - A Reconnaissance Space Sensing Investigation of
Crustal Structure for a Strip from the Eastern Sierra Nevada
to the Colorado Plateau, dated April 1971.

Reference: Proposal Control No. SR103
GSFC Principal Investigator ID PRO 15
ERTS-A Contract NAS5-21809, Ira C. Bechtold, P. I.

Gentlemen:

In accordance with Article II, Item 3, and Paragraph 3.1 of the referenced contract,
we hereby report the status of our ERTS-1 investigation.

I. Contract Objectives:

- A. Analysis, interpretation and evaluation of ERTS-1 data for application to
study of regional crustal structure.
- B. Comparison and evaluation of selected available remote sensing techniques,
including Apollo-9, X-15 and U-2 photography.
- C. Field Investigations to confirm interpretation studies and evaluate significance
and practical applications of geologic phenomena visible in ERTS imagery.

(E73-10355) A RECONNAISSANCE SPACE
SENSING INVESTIGATION OF CRUSTAL STRUCTURE
FOR A STRIP FROM THE EASTERN SIERRA
NEVADA TO (Argus Exploration Co., Newport
Beach, Calif.) 9 p HC \$3.00 CSCL 08G

N73-19351

Unclas
G3/13 00355

II. Summary of Work Performed:

A. Data Handling:

ERTS-1 and other remotely sensed imagery is now available for rapid recall in an efficient filing system. Indexing and plotting of NASA U-2, USAF U-2, SLAR, X-15 and NIMBUS imagery is continuing.

B. Literature Research:

Indexing of new literature has been improved by cross referencing by author and title. This literature filing system is working well. New journal subscriptions are adding significantly to our literature bank. Data sources include ReDaf, NASA-MSC; WESRAC, University of Southern California; EROS, Sioux Falls, South Dakota; Pomona College; U. S. Geological Survey.

C. Scientific Communications and Correspondence:

Data exchanges and discussions with members of the University of Southern California Engineering Department, particularly Professor William Pratt, regarding possible experiments in computer enhancement of ERTS-1 imagery were conducted. This has been discussed with Mr. Ed Crump and a computer compatible tape has been requested for one frame (1052-17490, 12 February 1973) on the east side of our area where we have extensive imagery including X-15, U-2, Apollo-9, SLAR and ERTS-1. Also, extensive field work has been done and reports have been written concerning this area which includes Lake Mead, the Colorado River and other important terrane. (See especially our report at ERTS-1 Symposium, March 5-9, 1973 and other previous reports.)

The ground track maps for USAF X-15 imagery have been obtained through the NASA Research Center, Edwards Air Force Base, California, working with Mr. Clinton Johnson, NASA TU Officer. A visit was made to Edwards AFB where arrangements were made through Mr. Johnson to inspect all X-15 photography now at Wright Patterson AFB and secure copies through Mr. Don Groening.

Comparison of color compositing techniques and exchange of methods have been carried out with personnel of Hughes including Mr. Phil Lohman, Miss Virginia Norwood and Mr. Ralph Yeaman.

Written correspondence regarding the applicability of ERTS data to a regional study of Zacatecas Province in Mexico was carried on with Dr. Lou A. Fernandez, Louisiana State University at New Orleans.

Oral correspondence with other ERTS-1 investigators included: Dr. Robert M. Weidman, University of Montana, and Dr. E. W. Tisdale, University of Idaho. Ideas have been exchanged with Robert E. Frazer, Jet Propulsion Laboratory, Pasadena, California.

D. Image Enhancement Analysis:

We have continued enhancement experimentation on ERTS-1 MSS images over our test site. Experiments have been conducted using photographic edge enhancement of black and white ERTS images and the results are quite useful in analyzing lineament patterns. Experimentation with a Ronche grating and a Fresnel lens has continued as part of routine imagery analysis using our Spectral Data multispectral viewer.

The most promising of our imagery enhancement techniques have been carried out by Wallace MacGalliard of MacGalliard Color Prints, North Hollywood, California.

In addition to photographing directly off the screen of the MSS viewer, MacGalliard has made 3-band dye transfer false color prints from registered ERTS 70mm and 9 x 9 inch transparencies. These composites are extremely sharp and clear and are far superior, although more costly, than previous results obtained by photographing directly from the MSS viewer screen. MacGalliard has also obtained good results by making false color composites from 9 x 9 inch negatives through an Ektachrome color process. These are better than those obtained by photographing directly from the viewer screen and are less costly than the dye transfer composites.

E. Imagery Comparison and Evaluation:

The quality of the raw ERTS-1 imagery received from NDPF has improved and we are now able to see details more clearly than was possible before. Dye transfer ERTS color composites over our test area have proven extremely useful for picking out detail of fairly small tectonic features such as faults in alluvium. The ERTS color composites are far superior to Apollo-9 imagery in resolution and in geometric fidelity and much more detailed geologic information can be derived from ERTS than from the color very oblique Apollo-9 imagery which is the only equatorial orbital spacecraft over this area. The broad overview provided by NIMBUS imagery makes it a useful adjunct to ERTS and Apollo-9 imagery.

The limited available coverage of NASA - U-2 color infrared imagery has been extremely useful for detailed work within larger anomalous zones recognized in ERTS imagery. Black and white U-2 imagery is also very useful in this regard but seems to be less sensitive to composition differences in alluvium than the color IR U-2 imagery.

SLAR has been useful in defining older faults in alluvium characterized by changes in sediment texture and is an important adjunct to U-2 imagery in the limited areas for which SLAR is available. Bedrock faults are especially apparent in SLAR imagery.

F. Geologic Field Reconnaissance and Mapping:

Four days were spent doing field work in an area which encompasses a large transverse structure at the southern end of a zone of crustal extension centered on the Colorado River south of Lake Mead, Nevada-Arizona. In addition, more work was done on the distribution of recent faults in alluvium, tertiary plutons, dikes, volcanics and areas of mineralization. The area covered extends roughly from Blythe, California on the south to Nelson, Nevada on the north.

New information was gained on the mechanisms of extensional tectonics as well as the characteristics of a major zone of strike slip movement and related plutonism and volcanism.

III. Conformance to Work Schedule:

A shift in work schedule has resulted from the large amount of time required for preparation of a paper and talk titled "Regional Tectonic Control of Tertiary Mineralization and Recent Faulting in the Southern Basin-Range Province - An Application of ERTS-1 Data" which was presented at the ERTS-1 Symposium held March 5-9, 1973. Significant results and three of our slides were included in the Invited Summary of Selected Disciplines by Professor Lattman. W. E. Hosken, I. C. Bechtold, and M. A. Liggett attended the symposium.

Foul weather over much of our test area has restricted field work to some extent and the resultant swollen streams presented time-consuming obstacles.

We have not completed all of the work planned for this report period.

IV. Analysis of Research Progress:

Field research during the period of this report has been quite limited. The time spent in the field was one of heavy rain and progress was hampered by flooding. Low altitude aerial reconnaissance and photography had been planned for the southeastern part of the test area, but was precluded due to poor visibility and low ceiling.

Image enhancement and image analysis has proceeded to our satisfaction and we will continue to experiment with new processes and techniques.

Compilation of age date, and mineral deposit maps for the ERTS-1 test area has moved ahead on schedule and these compilations are available to other workers at cost upon request.

V. Efforts to Achieve Reliability and Recommended Changes in Operation:

Efforts to create our own ERTS color composites have provided very useful and reliable results.

The quality of ERTS data received from NDPF has improved, and this has added greatly to successful image analysis and enhancement.

VI. Significant Scientific Results:

Significant results are contained in the two reports cited in Section X below. Abstracts for these reports are included in Section X.

VII. Funding Status:

As indicated in financial reports 533 Q and 533 M dated 15 January 1973 and in reports 533 M dated 15 February and 14 March 1973, proposed project funding will be sufficient to complete the contracted research program.

VIII. Scientific Staff and Back-up Personnel:

The following personnel are presently assigned to the ERTS-1 investigation:

Scientific Staff

I. C. Bechtold, Principal Investigator
M. A. Liggett, Field Geologist and Co-Investigator
J. F. Childs, Field Geologist

Technical Aids

R. L. Hutchens, Field and Office Assistant

Backup Personnel (covered in G & A)

Accountant

IX. Work Planned for Next Reporting Period:

A. Field Reconnaissance:

Field work will be conducted next in the northeastern sector of the test area northeast of Las Vegas to Cedar City, Utah. Tertiary andesitic to rhyolitic volcanism and shallow plutonism in this region will be investigated and the relationship of these phenomena to major structures recognized in ERTS-1 imagery will be analyzed.

Another area of interest lies between Tonopah, Nevada on the north and Beatty, Nevada on the south, where a large structural anomaly has been recognized in ERTS-1 imagery.

Work will continue on a large alluvial fan recognized in Apollo and ERTS imagery near Wrightwood, California. A large wedge shaped anomaly near Barstow, California will also be field checked.

B. Image Enhancement and Analysis:

The image enhancement techniques developed for ERTS-1 data in coordination with Wallace MacGilliard will continue. We will also continue to experiment with directional enhancement with a Ronche grating and edge enhancement. False color compositing of like and cross polarized SLAR image pairs is planned.

C. Data Source Research:

We will continue to accumulate and index pertinent reference material on our study area. We hope to obtain computer compatible geological and geophysical data such as epicenter and focal depth earthquake data and gravity and geomagnetic data for our test area which will then be computer trend surfaced in order to analyze regional patterns for comparison with ERTS-1 data.

X. Authorized Reports and Publications:

Regional Tectonic Control of Tertiary Mineralization and Recent Faulting in the Southern Basin-Range Province - An Application of ERTS data.

by: Ira C. Bechtold, M. A. Liggett and John F. Childs.

Paper presented at the ERTS-1 Symposium to be held March 5-9, 1973 at New Carrollton, Maryland.

Evidence of a Major Fault Zone along the California - Nevada State Line, 35°30' - 36°30'N Latitude.

by: Ira C. Bechtold, M. A. Liggett and John F. Childs.

Report of Investigation being submitted under separate cover.

Both of the reports listed above contain significant results of our ERTS-1 project.

REGIONAL TECTONIC CONTROL OF TERTIARY MINERALIZATION AND
RECENT FAULTING IN THE SOUTHERN BASIN-RANGE PROVINCE

An Application of ERTS-1 Data

I. C. Bechtold, M. A. Liggett and J. F. Childs
Argus Exploration Company
Newport Beach, California

Analysis of ERTS-1 MSS imagery over the southern Basin-Range Province of California, Nevada and Arizona has led to recognition of regional tectonic control of volcanism, plutonism, mineralization and fault patterns. This conclusion is the result of geologic reconnaissance of anomalies observed in ERTS-1 and Apollo-9 data, guided by intermediate scale U-2 photography, SLAR, and relevant geologic literature.

The area studied is an elongate province, 125 by 25 miles, oriented along the Colorado River between 34°15'N and 36°45'N. During mid-Tertiary time, the area was the site of widespread rhyolitic to andesitic volcanism and genetically related plutonism. The volcanics were fed by massive fissure systems, now exposed as dike swarms. Our reconnaissance has shown that dikes, elongate plutons, and penecontemporaneous normal faults trend generally north-south. These features are believed to have resulted from east-west crustal extension of several tens of kilometers.

The extensional province is the site of gold and silver mineralization, closely related to the Tertiary igneous activity. Metal recovered from this province is estimated to have a 1973 value of approximately \$100 million, although mining is largely inactive at present. The similarities in ore and gangue mineralogy, structural relations, and rock type associations throughout the mining areas define a distinct metallogenic district. This regional pattern has not been reported in previous studies, and should be considered in future mineral exploration.

In addition to regional tectonic studies, the ERTS imagery provides a basis for detailed research of relatively small geologic features. Within the study area, ERTS-1 imagery was used to conduct mapping of faults which cut intermontane alluvial sediments. Many of these faults are believed to be of Recent age, and few have been reported in previous studies of the area. The capability for efficient regional surveys of Recent faulting has important applications in such fields as land use planning, geologic hazards study, civil engineering, and hydrology.

ABSTRACTEvidence of a Major Fault Zone Along the California-
Nevada State Line, 35°30' to 36°30' N. Latitude

Ira C. Bechtold, Mark A. Liggett, and John F. Childs

Interpretation of ERTS-1 and Apollo-9 space imagery and intermediate scale X-15 and U-2 photography indicates the presence of a major fault zone along the California-Nevada state line, here named the Pahrump fault zone. The zone is inferred to extend 75 miles from 35.5° N - 36.5° N. Field mapping confirms previously unreported evidence of fault breaks in bedrock, along range fronts and in Quaternary alluvium and lake sediments. Regional gravity lows and fault traces within the Pahrump fault zone form a general left stepping en echelon pattern. This pattern, the apparent offset of a Laramide thrust fault, a possible large scale drag fold and apparent offset of streams, lead us to postulate right lateral movement on the Pahrump fault zone. The trend and postulated displacement for this fault are similar to other major strike slip fault zones in the southern Basin-Range Province.

XI. Changes in Standing Order Form:

No changes have been necessary in our standing order form for this reporting period.

XII. NASA Data Request Forms:

Request for computer compatible tape for ERTS-1 image 1052-17490, bands 4, 5, 6, 7 c/o E. W. Crump, Goddard Space Flight Center, 12 February 1973. Data not received as of this date.

A handwritten signature in cursive script, reading "Ira C. Bechtold".

Ira C. Bechtold
Principal Investigator